

Age Estimation among Adolescent Individuals from Fusion of Tri-Radiate Cartilage: A Radiological Study from Central India

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Abstract

Age determination in living individuals, dead persons & in human remains may shed light on issues with notable legal and social consequences for individuals as well as for the community. In the age determination of the deceased individual; the post-mortem circumstances can change the body parts and make age estimation difficult. In such cases, skeletal remains are extremely helpful for age determination. This study focuses on investigating the relationship between the stage of fusion of tri-radiate cartilage of innominate bone & biological age in population of Central India. This study was carried out in 120 healthy subjects (60 males and 60 females) aging from 12 to 18 years. The obtained results revealed that the complete fusion of tri-radiate cartilage is seen at 16-17 years. Comparatively, females were developing union at a younger age than their male counterparts. Results also suggest that the age of fusion of tri-radiate cartilage is found to vary greatly all over the India & world, indicating the need for separate standards for separate regions.

Keywords: *Tri-radiate cartilage, innominate bone, Central India.*

Introduction

Precise age determination of an individual is foremost in matters with respect to law and medicine. The word 'Adolescent' literally means 'passing from childhood to maturity'. WHO defines 'Adolescents' as individuals in the age group of 10-19 years. However, among this age group, individuals of 14 to 16 years are considered immensely important in routine medico-legal practices as they are more pivotal in matters (civil or criminal) with reference to sexual offences, kidnapping, juvenile delinquency, substance abuse, child marriages, factory employment & so on. All over the world, parameters like secondary sexual characters,

skeletal ossification progression, time of eruption of teeth etc are admissible in court as unparalleled scientific evidence in deciding disputes in adolescent age determination. All these parameters at their best can tend to fix the age of the person (either live or dead) only at a near approximate range and not the exact age. It is also true for bio archaeological studies, where the reconstruction of health and disease patterns or demography of past societies is evaluated. The fusion of the various epiphyses occurs at a specified order and period of time in life and their interrelationship is useful to establish an age in both living & dead cases. By taking into account the radiological analysis of fusion of tri-radiate cartilage, this study will be of enormous help in further understanding the details of accurate assessment of age in Juvenile population of Central India.

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Aims and Objectives:

1. To evaluate age specific difference in fusion of tri-radiate cartilage.

2. To estimate age from fusion of tri-radiate cartilage.
3. To compare bisexual difference in fusion of tri-radiate cartilage.
4. To compare the findings of fusion of tri-radiate cartilage in Central Indian population with other parts of India & the world.

Material and Method

The present study was carried out in the Department of Forensic Medicine in collaboration with Department of Radiology, DMMC, Nagpur. A total of 120 individuals participated in this study. The subjects included were individuals of 12-18 years of age from Nagpur city. They are born to parents domiciled from Central India & have been residing here since birth. The subjects do not have any disease/deformity associated with bones or chronic disease affecting the general health. Age was confirmed from history and from documents like driving license, passports, ration card, voter's card, Aadhar card etc. An informed consent was taken from all the subjects prior to each procedure. X-rays of Tri-radiate cartilage, AP & lateral views were taken & five different stages of union were graded. The 5 stages are: F1 (Non union): epiphyseal cartilage did not begin to decrease in thickness, F2 (Commence of union): thickness of epiphyseal cartilage was found to be reduced appreciably (1/4th united), F3 (Incomplete union): epiphysis has begun to fuse with shaft and complete union was well underway (1/2 united), F4 (Complete union): epiphyseal cartilage was bony in architecture and its density indistinguishable from the epiphysis & diaphysis in its neighbourhood but an epiphyseal line called epiphyseal scar could still be distinguished. (3/4 united) & F5 (Complete union): absence of epiphyseal scar. The appearance and fusion of Triradiate Cartilage was assessed radiologically and the results were compared with the previous known standard studies.

Results

In males, Triradiate cartilage shows: commencement of fusion in 12 (20%) cases in age group of 12-14 years,

Incomplete fusion in 9 (15%) cases in age group of 13-15 years, complete fusion with epiphyseal scar in 14 (23.33%) cases in age group of 13-16 years & complete fusion without epiphyseal scar in 25 (41.66%) cases in age group of 15-18 years. Complete fusion is seen in all the subjects in age group of 16-18 years.

Table 1: Extent of fusion of Triradiate cartilage in males:

Age (Years)	F1	F2	F3	F4	F5
12-13	0	10	0	0	0
13-14	0	2	6	2	0
14-15	0	0	3	7	0
15-16	0	0	0	5	5
16-17	0	0	0	0	10
17-18	0	0	0	0	10

Table 2: Extent of fusion of Triradiate cartilage in females:

Age (Years)	F1	F2	F3	F4	F5
12-13	2	8	0	0	0
13-14	1	9	0	0	0
14-15	0	2	6	2	0
15-16	0	0	0	3	7
16-17	0	0	0	0	10
17-18	0	0	0	0	10

In females, Triradiate cartilage shows: non fusion in 3 (5%) cases in age group of 12-14 years, commencement of fusion in 19 (31.66%) cases in age group of 12-15 years, Incomplete fusion in 6 (10%) cases in age group of 14-15 years, complete fusion with epiphyseal scar in 5 (8.33%) cases in age group of 14-16 years & complete fusion without epiphyseal scar in 27 (45%) cases in age group of 15-18 years. Complete fusion is seen in all the subjects in age group of 16-18 years.

Discussion

Table 3: Comparison of Age of union (years):

Sr.No	Researcher	Region/population	Triradiate cartilage		
			Male	Female	Mixed
1	Davies & Parson ¹	English	-	-	16
2	Flecker ²	Australians	15	13	-
	Pillai ³	Madrasis	-	-	11-14
3	Galstaun ⁴	Indians	15-16	14	-
4	Chaurasia ⁵	Indians	-	-	16-17
5	Parikh ⁶	Indians	-	-	15-16
6	Krishnan Vij ⁷	Indians	-	-	15-16
8	Bangal R et al ⁸	Mumbai	16-17	16-17	-
9	SingiY et al ⁹	Karnataka	16-17	15-16	-
	Sankyanet al ¹⁰	Himachal Pradesh	15.5-17.5	13.5-15.5	-
	Kumar A et al ¹¹	Uttar Pradesh	15-16	15-16	-
	Shilajiya Det al ¹²	Gujarat	16-17	14-15	-
	Bhore D et al ¹³	Mumbai	15-16	16-17	-
	Naik M et al ¹⁴	Andhra Pradesh	15-16	14-15	-
	Tailor C et al ¹⁵	Surat	-	-	14-15
	Present study	Nagpur	16-17	16-17	-

The observations of present study for males, matches with work of Davies & Parson¹, Galstaun⁴, Chaurasia⁵, Parikh⁶, Krishnan Vij⁷, Bangal R et al⁸, SingiY et al⁹, Sankyanet al¹⁰, Kumar A et al¹¹, Shilajiya Det al¹², Bhore D et al¹³ & Naik M et al¹⁴. For females, the observations are in agreement with the findings of Davies & Parson¹, Chaurasia⁵, Parikh⁶, Krishnan Vij⁷, Bangal R et al⁸, SingiY et al⁹, Kumar A et al¹¹ & Bhore D et al¹³.

Summary and Conclusion

1. This study was conducted exclusively on the young indigenous population of Central India in the adolescent age group.
2. The union at Triradiate cartilage in both males & females is completed in all instances (100%) at the age of 16-17 years.
3. Central Indian inhabitants are of diverse type comprising of various castes, religions & tribes. The opinion about age should always be given in the range.

4. From this study, range of 1-2 years of margin of error can be concluded.
5. For age estimation, pertinent joints should be radiologically examined for different centres and opinion should be arrived considering the status of multiple centres.

Ethical Clearance: Taken from institutional ethics committee.

Source of Funding: Self.

Conflict of Interest: Nil.

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